Prevalence of Psychoactive Substances in Dutch and Belgian Traffic

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ABSTRACT. Objective: The purpose of this study was to compare the prevalence of psychoactive substances in general traffic in The Netherlands and Belgium. **Method:** Randomly selected car drivers and drivers of small vans in six police regions in The Netherlands and five police regions in Belgium were included between January 2007 and August 2009. Blood and oral fluid samples were analyzed for 23 substances, including ethanol (alcohol), by means of ultra performance liquid chromatography–tandem mass spectrometry or gas chromatography–mass spectrometry analysis. Samples were weighted according to the distribution of traffic over eight 6-hour periods. Substance groups were categorized in five mutually exclusive classes: single alcohol use, single illicit drug use, single medicinal drugs use, multiple drug use (including drugs from two or more separate substance groups but excluding alcohol), and drug use (either single or multiple) in combination with alcohol. **Results:** In total, 7,771 drivers (4,822 in The Netherlands and 2,949 in Belgium) were included in the study. In Belgium, the prevalence of single alcohol (6.4%) and single medicinal drugs (3.0%) was much higher than in The Netherlands (2.2% and 0.6%, respectively), whereas the single illicit drugs were more common in Dutch traffic (2.2%) than in Belgian traffic (0.6%). Compared with the estimated prevalence of psychoactive substances in the general driving public in Europe, the prevalence in Belgium (10.7%) was greater than the European average (7.4%), and the prevalence in The Netherlands was below the European average (5.5%). **Conclusions:** The observed prevalence of psychoactive substances varies largely between The Netherlands and Belgium. Probable reasons for the differences are the higher level of alcohol enforcement in The Netherlands and nonresponse bias in the Belgian study (for illicit drugs in particular). Furthermore, cultural differences and variances in prescription policy could also be influential. (*J. Stud. Alcohol Drugs, 73,* 000–000, 2012)

ALTHOUGH THE USE OF PSYCHOACTIVE substances by motor vehicle drivers is suspected as a major risk factor in traffic, valid information on psychoactive substance use by motorists is sparse (Behrensdorff and Steentoft, 2003; European Monitoring Centre for Drugs and Drug Addiction, 2008). Prevalence studies are, in general, complex and expensive to conduct, partly because of the relatively low incidence of psychoactive substances in traffic. For a study to have enough statistical power, many drivers need to be included.

Review studies report a large variation of drivers in general traffic positive for one or more psychoactive substances other than alcohol. It is difficult to directly compare the results of these roadside surveys because of differences in study design, such as the number of substances included, the analytical cutoff levels applied, and the biological matrix used (European Monitoring Centre for Drugs and Drug Addiction, 2008; Kelly et al., 2004; Walsh et al., 2004). In Norway, 4.5% of motor vehicle drivers were positive for psychoactive substances including illicit drugs, medicinal drugs, or alcohol (Gjerde et al., 2008). In Thailand, 5.5% of drivers tested positive for alcohol, and 9.7% of drivers were positive for other psychoactive substances (Ingsathit et al., 2009). In the state of Victoria, Australia, 2.4% of drivers were positive for methamphetamines, 3,4-methylenedioxymethamphetamine (MDMA, or Ecstasy), or tetrahydrocannabinol (THC, or cannabis). In the United States, 11% of drivers were positive for illicit and medicinal drugs during daytime hours on Friday and 14.4% during nighttime hours on Friday and Saturday nights (Lacey et al., 2009). In British Columbia, 10.4% of drivers tested positive for drug use on Wednesday and Saturday nights.

In the European research project DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines), prevalence studies have been conducted from 2007 to 2009 in 13 European countries (Houwing et al., 2011a, 2011b). Special attention was given to the comparability of these studies by using a common study design (Assum et al., 2007), which included recommendations on the type of road users and substances to be included, as well as the cutoff levels of these substances. Despite recommendations for a common

Received: February 3, 2012. Revision: June 14, 2012.

This article has been produced under the project Driving Under Influence of Drugs, Alcohol and Medicines (DRUID), financed by the European Commission within the framework of the European Union 6th Framework Program. This report reflects only the authors' views. The European Commission is not liable for any use that may be made of the information contained therein.

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design, some differences could not be ruled out for practical, legislative, or medical ethical reasons. The main difference in the design of these 13 studies was that some countries used blood as the biological matrix, some used oral fluid, and some used a combination of both. To be able to compare the results from countries that used blood with countries that used oral fluid, equivalent cutoffs were applied, as reported by Verstraete et al. (2011b) and Gjerde et al. (2010). When using equivalent cutoff concentrations in blood and oral fluid, the prevalence of a drug will be equal in samples of blood and samples of oral fluid when studying a large cohort. Based on the outcomes of these 13 studies and after application of weighing factors for country size and size of the represented European regions, it was estimated that an average of 1.89% of the drivers in the European Union were positive for illicit drugs, 1.39% for medicinal drugs, 3.48% for alcohol, 0.39% for polydrug use, and 0.37% for the combined use of alcohol and other drugs (Houwing et al., 2011a).

Belgium and The Netherlands are two neighboring countries in Western Europe that shared a common history until 1830, when Belgium separated from The Netherlands. Comparisons between Belgium and The Netherlands are commonly made because of their historical and cultural bonds. A comparison of Dutch and Belgian results is also interesting because they were the only two Western European countries that were involved in the DRUID roadside surveys. This article reports on and compares the use of psychoactive substances in traffic based on results of the Belgian and Dutch prevalence studies that were conducted in the European DRUID project. Furthermore, Dutch and Belgian results are compared with the estimated European mean and with previously conducted national studies in Belgium and The Netherlands on the use of psychoactive substances in traffic.

Method

General design

A cross-sectional roadside survey was conducted to determine the prevalence of psychoactive substances among the general driving population in Belgium and The Netherlands. A stratified multistage sampling design was used. In the first stage, five study regions were selected in Belgium and The Netherlands. These regions were meant to be representative of the entire country with regard to substance use and traffic. Within these regions, smaller research areas (five Belgian and six Dutch police regions) were selected in the second stage. Within these areas, survey locations were selected in which car drivers and van drivers were randomly selected from actual traffic between January 2007 and August 2009. For each police region, data were collected during several roadside survey sessions distributed over eight 6-hour periods covering all hours of the day on both weekdays and weekend days. The periods were distributed into type of day (weekday/weekend day) and time of day (4:00 A.M.–9:59 A.M., 10:00 A.M.–3:59 P.M., 4 P.M.–9:59 P.M., and 10 P.M.–3:59 A.M.).

Drivers were stopped by the police at the request of the research coordinator. As soon as an interviewer/nurse was ready for interviewing and blood sampling, a driver (i.e., the next car approaching the research site) was stopped. Drivers who were stopped were asked to cooperate with the study on a voluntary basis. Drivers who agreed to cooperate were interviewed about their drug and medicine use. Apart from self-reported drug use and time of administration, data collection also comprised date and time of selection, gender and age of the subject, and signs of impairment. In Belgium, all drivers were asked to provide both blood and oral fluid samples. If drivers refused to give a blood sample, a single oral fluid sample was requested. In the Belgian study, participating drivers received a reward of €20. In the Dutch study, all drivers were asked to give a blood sample. If drivers refused to give a blood sample, an oral fluid sample was requested. Participants received a €5 reward for an oral fluid sample and a €10 reward for a blood sample. In case drivers reported recent drug use, an additional oral fluid sample was requested after collecting a blood sample.

In The Netherlands as well as in Belgium, the breath test was compulsory for all drivers who were stopped. In The Netherlands, participants were breath tested for alcohol by a police officer after the interview and the blood or oral fluid sampling. Drivers who refused to participate were breath tested for alcohol by a police officer, and, if possible, additional information was collected including information on age, gender, clinical signs of impairment, and reason for refusal. In Belgium, all drivers who were stopped were breath tested before the request regarding participation in the study.

Ethical approval

In Belgium, the protocol was approved by the ethics committee of Ghent University Hospital. Participants needed to sign an informed consent. No ethical approval was needed in The Netherlands. After having been informed about the project, the ethics committee made clear that "the project is not encompassed by the law on ethics committees and consideration regarding bio-medical research projects. Therefore, the project does not have to be announced to the ethics committee." Hence, no informed consent was requested. However, participants in The Netherlands were informed both in writing and by oral communication about the study and its voluntary nature.

Sample preparation and analysis

Venous blood samples were collected in glass tubes containing 20 mg sodium fluoride and 143 IU heparin sodium

(BD Plymouth, Brest, The Netherlands, and Terumo, Leuven, Belgium). In The Netherlands, oral fluid samples were taken by having the participant spit into a polypropylene container (Deltalab, Barcelona, Spain). In Belgium, oral fluid samples were collected by using the StatSure Saliva Sampler (StatSure Diagnositc Systems, Inc., Brooklyn, MA). In The Netherlands, estimated blood alcohol concentration (BAC) was measured with a handheld breath alcohol analyzer using a Dräger Alcotest 7410 Plus screening device (Dräeger Safety Inc., Lübeck, Germany). In Belgium, BAC was estimated from both oral fluid and whole blood. For drivers from whom only oral fluid samples were collected, results for ethanol (alcohol) in oral fluid were converted using the following formula:

$$\text{Calculated blood ethanol (\%)} = \text{measured ethanol in oral fluid (g/L)} \times 1.22.$$

The applied factor of 1.22 was based on the average conversion factor between blood and oral fluid that was calculated from the Belgian DRUID results of those drivers from whom both blood and oral fluid samples were collected (Verstraete et al., unpublished observations).

In Belgium, the following methods were used for toxicological analysis of whole blood samples: an enzymatic method for ethanol analysis, a solid-phase extraction followed by ultra performance liquid chromatography–tandem mass spectrometry (UPLC-MS/MS) analysis for all substances except cannabinoids, enzyme-linked immunosorbent assay (ELISA) screening (qualitative) for cannabinoids, and liquid–liquid extraction followed by gas chromatography–mass spectrometry analysis for samples that gave positive results at the ELISA screening for cannabinoids.

An enzymatic method for ethanol analysis and protein precipitation, followed by UPLC-MS/MS for all other substances, was used for the Dutch toxicological analysis of whole blood samples. Four rounds of proficiency testing were organized in the participating countries during the study.

In The Netherlands, the conversion factor of breath alcohol concentrations into BACs in percentages is 1:23 (Mathijssen and Twisk, 2001). However, in other European countries that were involved in the DRUID roadside surveys, a higher conversion factor of 1:21 is used (Melethil, 2011). To be able to compare the Dutch alcohol results with the results for other European Union countries, all BAC results from The Netherlands were multiplied by a factor of 1.095 (23 / 21).

Equivalent cutoffs

In total, 23 substances were included in the analysis. Selection of these substances was based on their prevalence of use in the general population and their possible influence on driving ability. Results were presented by using equivalent cutoffs. When using equivalent cutoff concentrations in blood and oral fluid, the prevalence of a drug will be equal in samples of blood and samples of oral fluid when studying a large cohort. The reason for applying equivalent cutoffs is that, for many substances, concentrations in oral fluid are much higher than in blood, whereas for some compounds the concentrations are lower (Verstraete et al., 2011b). Table 1 provides an overview of the applied cutoff concentrations. In case both blood and oral fluid samples were available, the result from the blood analysis was leading.

TABLE 1. Applied cutoffs for psychoactive substances other than alcohol; THC-COOH is not included in this table because THC-COOH was not analyzed in oral fluid

Substance group/substance	Cutoff in oral fluid (ng/mL)	Cutoff in whole blood (ng/mL)
Amphetamines		
Amphetamine	360	20
Methamphetamine	410	20
MDA	220	20
MDEA	270	20
MDMA	270	20
Cocaine		
Cocaine	170	10
Benzoylecgonine	95	50
Cannabis		
THC	27	1.0
Illicit opiates		
6-Acetylmorphine	16	10
Benzodiazepines		
Diazepam	5.0	140
Flunitrazepam	1.0	5.3
Lorazepam	1.1	10
Alprazolam	3.5	10
Clonazepam	1.7	10
Nordiazepam	1.1	20
Oxazepam	13	50
Medicinal opioids		
Methadone	22	10
Medicinal opioids or illicit opiates		
Morphine	95	10
Codeine	94	10
Z drugs		
Zolpidem	10	37
Zopiclone	25	10

Notes: TCH-COOH = 11-nor-9-carboxy-tetrahydrocannabinol; MDA = methylenedioxyamphetamine; MDEA = 3,4-methylenedioxy-*N*-ethylamphetamine; MDMA = 3,4-methylenedioxymethamphetamine; THC = tetrahydrocannabinol.

Substance groups and classes`

For calculating prevalence, substances of the same type were aggregated into substance groups. All groups were mutually exclusive, meaning that each record was either negative or linked to one of the following groups: alcohol, amphetamines, cocaine, THC, illicit opiates, benzodiazepines, Z drugs (nonbenzodiazepine medications mainly used for the treatment of insomnia), and medicinal opioids. Samples in which only THC-COOH (11-nor-9-carboxy-THC; a metabolite of THC that is detectable in blood and that occurs in very

TABLE 2. Distribution roadside survey sample by age and gender; excluding 5 missing values for respondents in The Netherlands and 21 missing values for respondents in Belgium

	The Netherlands respondents (n = 4,817)			Belgium respondents (n = 2,928)		
Age, in years	Male	Female	Total	Male	Female	Total
18–24	7.3%	3.2%	10.5%	6.3%	3.8%	10.1%
25–34	15.1%	5.9%	21.1%	12.6%	8.5%	21.5%
35–49	23.8%	12.0%	35.8%	25.3%	12.5%	37.8%
≥50	23.6%	9.0%	32.6%	22.7%	8.4%	31.1%
Total	69.8%	30.2%	100%	66.8%	33.2%	100.0%

low concentrations in oral fluid) was detected were regarded as negative. Samples that included substances from two or more substance groups were included either in the drug–drug combination group or in the alcohol–drug combination group, depending on the presence of alcohol. More detailed information on the aggregation into substance groups and classes can be found in Houwing et al. (2011a).

Morphine and codeine concentrations could be classified as medicinal opioids or as illicit opiates. Morphine and codeine were regarded, in general, as medicinal opioids, except in those cases when they were detected in combination with each other and when the concentration of morphine was higher than the concentration of codeine. A higher concentration of morphine would suggest the use of an illicit opiate such as heroin.

Weighing factors

Because random sampling was applied, drivers were expected to be representative of gender and age during sampling sessions. However, because police preferences had to be considered, the selection of samples could not be distributed equally with traffic volumes over the different periods. To correct for the difference between distribution of roadside samples and distribution of traffic over eight different periods, weight factors were calculated by dividing the general distribution of traffic by period by the distribution of sampled drivers in the same period. The weighing procedure in The Netherlands was based on 2007–2008 national trip distribution data from the National Travel Survey collected by the Dutch Central Bureau of Statistics (Central Bureau of Statistics, 2011), and the weighing procedure in Belgium was based on 2007 traffic counts from the Flemish Government's Agency for Roads and Traffic (Agentschap Wegen en Verkeer, 2007).

Statistical analysis

Weighted prevalence was calculated by using descriptive statistics by means of the statistical software SAS Version 9.2 (SAS Institute, Cary, NC). Tables were created by using a FREQ procedure including a statement on the weight factors to be used. Weighted prevalence of the substance under scrutiny was calculated by dividing the weighted number of positives for this substance by the weighted total of samples. For calculating confidence intervals, the Wilson confidence interval formula (Wilson, 1927) was used because lower and upper confidence limits calculated using traditional approximations may result in limits outside the (0,1) interval. Possible differences in substance use between the two countries were investigated with binomial logistic regression in SPSS Version 16.0.1 (SPSS Inc., Chicago, IL). Type of country was used as a covariate (with two categories: 0 = Belgium, 1 = The Netherlands), and each substance was included as a dependent variable (also with two categories: 0 = negative, 1 = positive). In all statistical tests, the conventional critical 5% level was used to assess whether the obtained odds ratio (OR) significantly deviated from 1.

Results

Study population

In The Netherlands, 5,064 drivers were asked to participate in this study. Of these drivers, 242 (4.8%) declined and 4,822 (95.2%) agreed to participate. In Belgium, 6,155 drivers were asked to participate. Of these drivers, 3,206 (52.1%) refused and 2,949 (47.9%) agreed to participate. Of the 4,822 participating drivers in the Dutch study, 3,476 (72%) provided a blood sample, 1,068 (22%) provided an oral fluid sample, and 278 (6%) provided both a blood and an oral fluid sample. As stated previously, in case both blood and oral fluid samples were collected, the results of the blood analysis were leading. In the Belgian study, 2,750 (93%) of the 2,949 participating drivers provided both blood and oral fluid samples, and 199 (7%) provided an oral fluid sample only. Table 2 provides an overview of the distribution of the participating drivers by age and gender. No information on age was available from 5 drivers in The Netherlands and 21 drivers in Belgium.

There was no significant difference in the age and gender distribution between the two survey samples. Distribution

TABLE 3. Adjusted general distribution of core substances including 95% confidence intervals

Variable	Substance group	Prevalence The Netherlands, % (n = 4,822)	Prevalence Belgium, % (n = 2,949)
Negative	Negative	94.49 [93.81, 95.10]	89.35 [88.18, 90.41]
Alcohol	Alcohol alone >.01%	2.15 [1.78, 2.60]	6.42 [5.59, 7.36]
	Alcohol .05%–.079%	0.26 [0.15, 0.44]	1.33 [0.97, 1.81]
	Alcohol .08%–.119%	0.14 [0.07, 0.29]	0.42 [0.24, 0.72]
	Alcohol ≥.12%	0.21 [0.12, 0.39]	0.41 [0.23, 0.71]
Illicit drugs	THC alone	1.67 [1.34, 2.07]	0.35 [0.19, 0.64]
	Cocaine alone	0.30 [0.18, 0.50]	0.20 [0.09, 0.43]
	Amphetamines alone	0.19 [0.10, 0.36]	–[a]
	Illicit opiates alone	0.01[a] [0.00, 0.09]	0.09[a] [0.03, 0.28]
Medicinal drugs	Benzodiazepines alone	0.40 [0.25, 0.62]	2.01 [1.57, 2.59]
	Medicinal opioids alone	0.16 [0.08, 0.32]	0.75 [0.50, 1.13]
	Z drugs alone	0.04[a] [0.01, 0.15]	0.22 [0.10, 0.47]
Combinations	Multiple drugs	0.35 [0.22, 0.56]	0.30 [0.16, 0.58]
	Alcohol–drugs	0.24 [0.13, 0.42]	0.31 [0.16, 0.58]

Notes: THC = tetrahydrocannabinol. [a]Weighted $n < 5$.

of drivers in the Dutch roadside sample was comparable with the national distribution on gender, which accounts for 70.3% and 29.7% of male and female drivers, respectively (Central Bureau of Statistics, 2011 [National Traffic Survey]; Dienst Verkeer en Scheepvaart, 2011 [Dutch Mobility Survey]. Distribution by gender in the Belgian DRUID study was comparable to the distribution found in the 2007 Belgian roadside survey of drinking and driving, where 67% of the drivers were male and 33% of the drivers were female (DuPont, 2009).

A comparison of the response group with the nonresponse group in the Belgian study (Houwing et al., 2011b) showed that there was a small but significant overrepresentation of male drivers among the nonresponse group. This overrepresentation was mainly present in the 25- to 34-year-old age group. The prevalence of illicit drugs was generally higher among young male drivers (Houwing et al., 2011a, 2011b). Furthermore, it was shown that from 4:00 A.M. to 9:59 A.M. on both weekday/weekend days and from 10:00 A.M. to 3:59 P.M. on weekends, the refusal rates were highest. Alcohol prevalence among respondents did not differ with the prevalence found in nonrespondents (p = .321).

The nonresponse rate in The Netherlands was only 4.8%. The prevalence of alcohol was slightly higher for the nonresponse group than for the response group. However, the BAC distribution of the combined response and nonresponse group was almost identical to the BAC distribution of the response group alone. The self-reported use of psychoactive substances other than alcohol was higher for the nonresponse group. After correction for the unknown answers, 6.5% of the nonrespondents reported the use of psychoactive substances in the past 12 hours versus 3.6% of the respondents. When the self-reported use of the nonresponse group would have been added, the self-reported use of the total study population would increase just one tenth of a percentage point, from 3.6% to 3.7%.

Prevalence

Table 3 provides a general overview of the prevalence of psychoactive substances in Dutch and Belgian traffic. As mentioned above, the substance groups were divided into four drug categories: alcohol, illicit drugs, medicinal drugs, and combined use of drugs or drugs with alcohol.

Alcohol. In both countries, single alcohol use (BAC > .01%) was the most prevalent substance. The prevalence of single alcohol use in Belgian traffic (6.42%) was significantly higher (OR = 3.15, 95% CI [2.46, 4.03]) than in Dutch traffic (2.15%) (Figure 1). For each of the three BAC groups, the prevalence in Belgium was at least twice as high as in The Netherlands. However, the relative difference decreased at higher BAC levels. Alcohol was used in combination with other psychoactive substances far less frequently than alone. In The Netherlands, the prevalence of alcohol in combination with other psychoactive substances was 0.24%, which was 10% of the total prevalence of alcohol. In Belgium, the prevalence of alcohol in combination with other substances was 0.31%, which was 5% of the total prevalence of alcohol.

Illicit drugs. The illicit drug class consisted of four different illicit drug groups: amphetamines, cocaine, cannabis, and illicit opiates (Table 1). In The Netherlands, 2.17% of all drivers were positive for illicit drugs, whereas in Belgium the prevalence was lower, at only 0.64%, a significant difference (OR = 0.27, 95% CI [0.16, 0.45]). THC was by far the most frequently detected illicit drug in The Netherlands (1.67%) and in Belgium (0.35%). The THC prevalence in Belgium was significantly lower than in The Netherlands (OR = 0.21, 95% CI [0.11, 0.40]). Cocaine was detected among 0.30% of the drivers in The Netherlands and among 0.20% of the drivers in Belgium (OR = 0.69, 95% CI [0.26, 1.88]). This difference was not significant. Amphetamines were detected among 0.19% of the Dutch drivers and were completely absent among the Belgian drivers. Because of

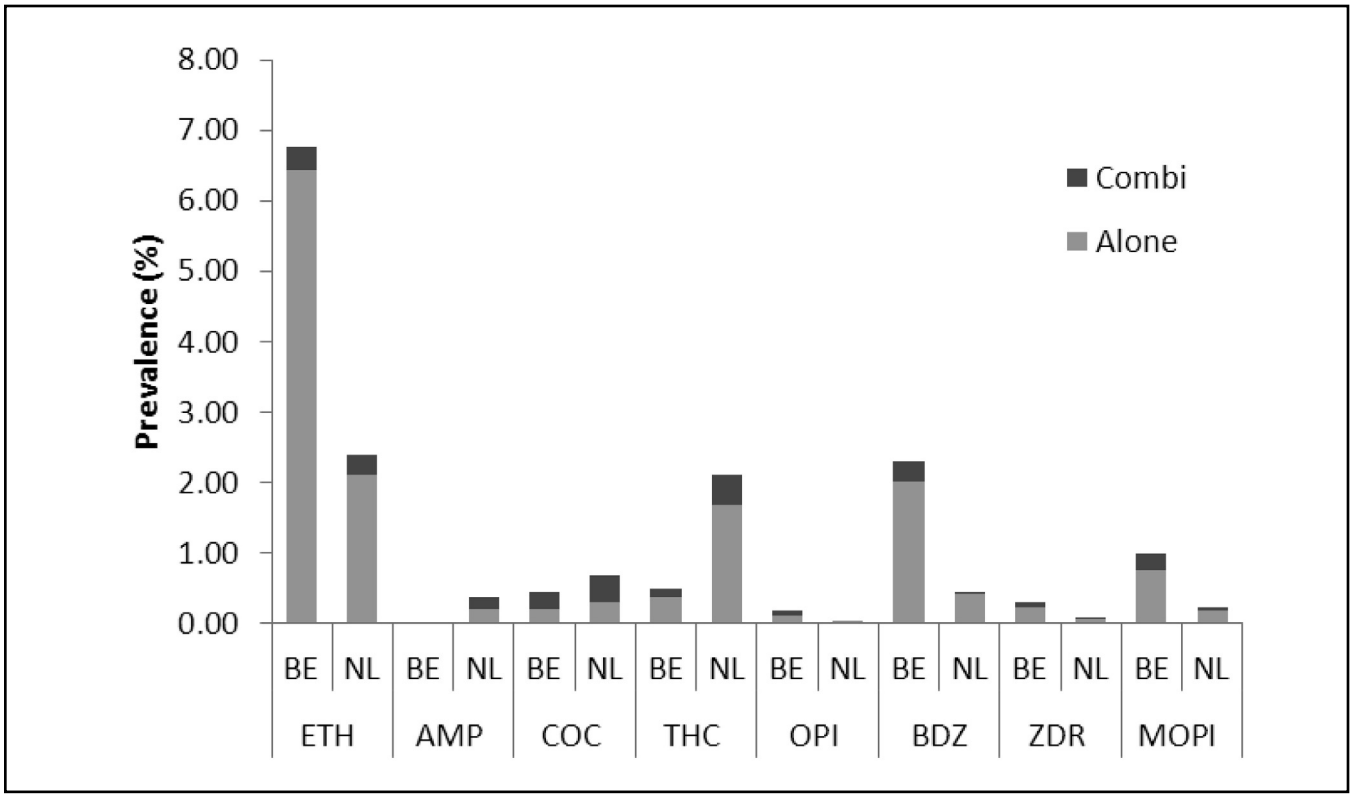

FIGURE 1. Prevalence of substances alone and in combination; prevalence in percentages. Combi = combination; BE = Belgium; NL = The Netherlands; ETH = ethanol (alcohol); AMP = amphetamines; COC = cocaine; THC = tetrahydrocannabinol (cannabis); OPI = illicit opiates; BDZ = benzodiazepines; ZDR = Z drugs; MOPI = medicinal opioids.

the absence of amphetamines in the Belgian study sample, a value of 0.1 was added to each of the four cells (Agresti, 1996), which resulted in a nonsignificant difference (OR = 0.02, 95% CI [0.00, 8.97]) between the Dutch and Belgian prevalence. Illicit opiates were rarely present (0.01%) in The Netherlands and sparsely detected in Belgium (0.09%). This difference was not significant either (OR = 11.11, 95% CI [0.29, 432.54]).

Medicinal drugs. The medicinal drugs class consisted of three different drug groups: benzodiazepines, medicinal opioids, and Z drugs (see Table 1). Medicinal drugs were significantly more prevalent in general traffic in Belgium (2.98%) than in The Netherlands (0.60%) (OR = 6.40, 95% CI [4.00, 10.25]). The most frequently detected medicinal drugs were benzodiazepines. In The Netherlands, 0.40% of the drivers were screened positive for benzodiazepines, as did 2.01% in Belgium (OR = 5.16, 95% CI [3.08, 8.66]) (Figure 1). Medicinal opioids were detected relatively frequently in Belgium (0.75%) but significantly less in The Netherlands (0.16%) (OR = 4.60, 95% CI [2.04, 10.37]). Z drugs were significantly more prevalent in Belgium (0.22%) than in The Netherlands (0.04%) (OR = 5.12, 95% CI [1.08, 24.31]).

Drug–drug and alcohol–drug combinations. Patterns of the prevalence of combinations of psychoactive substances were more or less the same in The Netherlands (0.24% alcohol–drugs and 0.35% drug–drug combinations) and in Belgium (0.31% alcohol–drugs and 0.30% drug–drug combinations). The corresponding odds ratios were not significant (alcohol–drugs, OR = 1.37, 95% CI [0.62, 3.00]; drug–drug combinations, OR = 0.76, 95% CI [0.34, 1.71]). Both in Belgium and in The Netherlands, cocaine was detected with approximately the same frequency alone as it was in combination with other substances. For THC, Z drugs, and medicinal opiates and opioids, the share of combined use was approximately 25% of the total use, whereas for alcohol and benzodiazepines the proportion was about 10% in both countries. For amphetamines (0.00% in Belgium) and illicit opiates (0.01% in The Netherlands), the prevalence was too low to compare between countries.

Comparison with previous studies in The Netherlands and Belgium

In The Netherlands, only one previous prevalence study had been conducted in the past 10 years on the prevalence of drugs and medicines in traffic (Mathijssen and Houwing, 2005). For alcohol prevalence, data were available on a yearly basis since 1974, but this information was only gath-

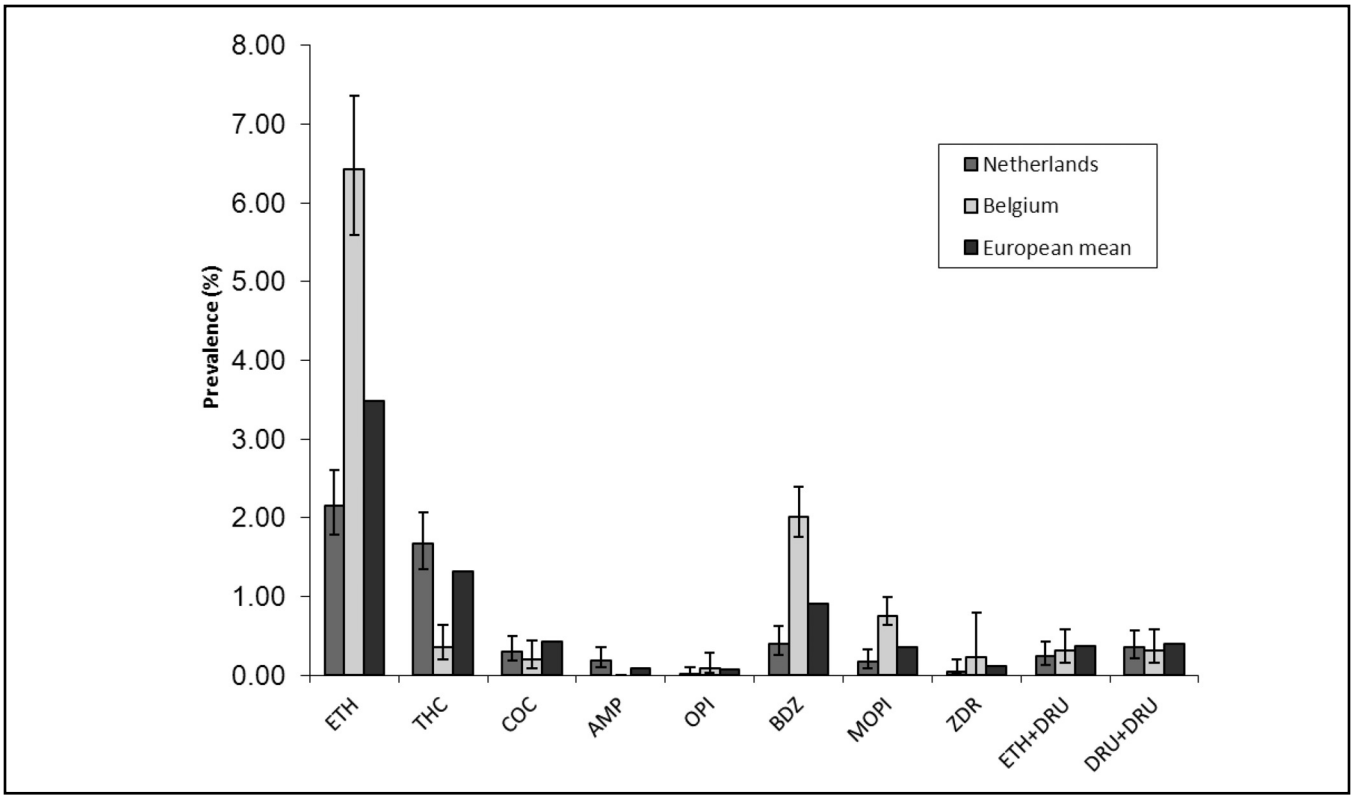

FIGURE 2. Comparison of national prevalence in Belgium and The Netherlands for various groups of substances including 95% confidence intervals with the estimated European mean. ETH = ethanol (alcohol); THC = single tetrahydrocannabinol (cannabis); COC = single cocaine; AMP = single amphetamines; OPI = single illicit opiates; BDZ = single benzodiazepines; MOPI = single medicinal opioids; ZDR = single Z drugs; ETH + DRU = alcohol–drugs combinations; DRU + DRU = drug–drug combinations.

ered during weekend nights (Dienst Verkeer en Scheepvaart, 2011). For the prevalence of alcohol during other periods, only data from the European research project IMMORTAL (Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing) were available (Mathijssen and Houwing, 2005).

Between 2000 and 2004, a roadside survey was conducted in the Dutch Tilburg police district as part of the European IMMORTAL study. The prevalence of single illicit drugs was higher in the IMMORTAL study (4.5%) than it was in the Dutch DRUID study (2.17%). However, the results of the IMMORTAL study were mainly based on urine samples in which drugs are detectable for a longer period than in blood and oral fluid (Verstraete, 2004). Therefore, a direct comparison between the prevalence rates of the IMMORTAL and DRUID studies was not possible.

In Belgium, national data on the prevalence of alcohol in traffic were available for the years 2003, 2005, and 2007 (DuPont, 2009). No previous data were available on the prevalence of other psychoactive substances in traffic. The prevalence of alcohol in the DRUID study was somewhat higher than the results from the biannual roadside survey on alcohol use, which found an average prevalence of 2% during the whole week for a BAC of 0.5 g/L and higher. In the DRUID study, this prevalence was 2.33%. These results did not significantly differ from each other.

Comparison with DRUID mean

Within the DRUID project, a European mean was estimated based on the prevalence of psychoactive substances in 13 different European countries including The Netherlands and Belgium using a uniform study design (Houwing et al., 2011). Figure 2 presents the comparison of the Dutch and Belgian prevalence data (including 95% confidence intervals) with the estimated European mean.

The results show that the relative position of the Belgian and Dutch results toward the European mean was mirrored for all substances. Benzodiazepines, medicinal opiates and opioids, and alcohol were more frequently detected in Belgium as opposed to the European mean, whereas in The Netherlands they were less frequently detected than in Europe. However, the prevalence of amphetamines and THC in Dutch traffic was above the European average, and the prevalence of these substances in Belgium was below average. The prevalence of cocaine, illicit opiates, Z drugs, alcohol–drugs, and drug–drug combinations in traffic varied between the two countries; but, for all of these substances,

the European mean was included in the confidence interval for both countries.

Discussion

Despite the fact that Belgium and The Netherlands are neighboring countries, the use of psychoactive substances in traffic was far from similar. In Belgium, the use of alcohol and medicinal drugs in traffic was higher than in The Netherlands, whereas the measured use of illicit substances in traffic was substantially higher in The Netherlands as compared with Belgium.

The higher prevalence for alcohol in Belgium might be related to differences in the enforcement level. The enforcement level for alcohol (number of alcohol tests per 100,000 inhabitants) is estimated to be three to four times lower in Belgium than it is in The Netherlands (Veisten et al., 2011). Furthermore, cultural differences may be causing higher alcohol use in Belgian traffic. For example, in Belgium, people tend to go out eating and drinking more often. This is reflected in the number of restaurants per 10,000 inhabitants. In The Netherlands, the number of restaurants per 10,000 inhabitants is approximately 35 (Bedrijfschap Horeca en Catering, 2011), whereas in the Flanders region—where about 60% of all Belgian inhabitants reside—the number of restaurants per 10,000 inhabitants is approximately 48 (GUIDEA, 2011).

The higher use of medicinal drugs in Belgium might be explained by a higher consumption of medicines in the general population. The average expenditure per person on medicines has been approximately 15%–20% higher in Belgium than in The Netherlands (Stichting Farmaceutische Kergetallen, 2011). The low expenditure in The Netherlands could partly be explained by a reluctant prescription policy of general practitioners.

The relatively low prevalence of illicit drugs that was found in Belgium may be related to the high nonresponse level. It can be expected that drivers who had recently used an illicit drug would be less likely to participate in the study because they might be afraid that the test results would be used for legal purposes (drug driving legislation of 1999). A lower participation rate of drug-positive drivers would result in nonresponse bias. Based on a comparison of the detected prevalence of illicit substances among injured drivers (Isalberti et al., 2011) and in the general population (Ravera and De Gier, 2008), a higher prevalence of illicit drugs in Belgian traffic would indeed be expected. The detected prevalence of illicit drugs in the general population was in fact comparable for the two countries, and the detected prevalence of illicit drugs among injured drivers was even higher for Belgium than it was for The Netherlands.

Another indication of nonresponse bias can be derived from the odds ratios for illicit drugs that were calculated by Hels et al. (2011). Because of the low prevalence of illicit drugs in Belgium, only an adjusted odds ratio for getting seriously injured in a car crash could be calculated for cannabis. The Belgian odds ratio for cannabis (4.88) was approximately three times higher than the mean adjusted odds ratio (1.38) in Hels et al. (2011), which was based on the combined data of four included countries (Belgium, Denmark, The Netherlands, and Lithuania). If the mean adjusted odds ratio would be applied to the Belgian hospital data, the estimated prevalence for THC in Belgian traffic is likely to be more comparable to the Dutch prevalence, although it is impossible to estimate the exact size of the potential nonresponse bias. Finally, keep in mind that, in this study, prevalence is based on predetermined limits of detection and not on limits of impairment.

Strengths and limitations

The main strength of the present study is the similar design of roadside surveys performed in both Belgium and The Netherlands, which makes it possible to compare the results between the two countries as well as with the estimated European mean. By using equivalent cutoffs for drugs in blood and oral fluid, the limitation of the comparability of the results when including two different body fluid samples (blood and oral fluid) was overcome. Another strength of this study is that blood and oral fluid samples were used, not urine samples. Blood and oral fluid can be used to detect recent drug use, whereas urine samples may reflect drug intake up to several days ago (Verstraete, 2004; Walsh et al., 2008). Furthermore, the study provides recent prevalence data of different psychoactive substances in the general driving population in Belgium and The Netherlands. For Belgium, this is the first large-scale study that includes information on the prevalence of illicit drugs in traffic.

A limitation of this study is that the list of analyzed substances was not exhaustive. For example, there was no screening for gamma-hydroxybutyric acid (GHB), only seven benzodiazepines were screened for, and selective serotonin reuptake inhibitors were not included. The very high nonresponse rate (52.1%) in Belgium is another limitation of the study because it could lead to nonresponse bias, especially for illicit drugs. Based on the assessment on possible confounding effects of nonresponse by comparing age, gender, and alcohol data, we can conclude that the possibility of nonresponse bias cannot be totally ruled out. Despite that there was a significant difference ($p < .001$) in self-reported use of psychoactive substances other than alcohol between the response and the nonresponse group in The Netherlands, the actual bias seems to be very small because of the small size of the nonresponse group.

Another limitation is that the studies in Belgium and The Netherlands did not collect oral fluid in the same way. The collection procedure may have influenced the concentrations of the samples, as described in previous literature (Crouch,

2005; Langel et al., 2008; O'Neal et al., 2000; Verstraete et al., 2011a). Furthermore, a recent study (Houwing et al., submitted for publication) shows that THC concentrations in oral fluid samples collected by spit tubes were on average 1.9 times higher than THC concentrations collected by the StatSure collection device. These findings indicate that the applied equivalent cutoff concentrations might have been too high for the Dutch study.

Finally, despite the large sample size of the Belgian and Dutch prevalence study, the cell counts for some substances were small or even zero, which resulted in less stable comparisons between the estimates of both countries.

Conclusion

The Netherlands and Belgium are neighboring countries. Nonetheless, statistical significant differences are present in the prevalence of psychoactive substances in traffic. In general, medicinal drug use and alcohol were more frequently detected in Belgian traffic, whereas illicit substances were more prevalent in The Netherlands. However, when comparing the results of roadside surveys with hospital data and data from illicit drug use in the general population, it is likely that the observed prevalence of illicit drugs at the Belgian roadside was underrepresented and that the prevalence of illicit drugs in Belgian traffic is probably higher than the current results show.

Acknowledgments

The Dutch roadside survey was conducted in close cooperation with one police district and five regional traffic enforcement teams of police, accounting for six different areas in The Netherlands (Amsterdam Amstelland, Hollands Midden, Tilburg, Twente, Groningen, and Gelderland-Zuid) and three in Belgium (Flanders, Brussels, and Wallonia). The authors are grateful for the dedication of the police staff and executive personnel. Many participated on a voluntary basis to make the survey a success. We also thank the Department of Toxicology of The Netherlands Forensic Institute (The Hague, The Netherlands) for undertaking the analysis of blood and saliva samples.

The researchers are grateful to all the students who helped to collect the prevalence data in Belgium. Special thanks go to Luc Claus and the emergency department of the Regional Hospital of Namur for help with blood sampling, as well as to Kristof Pil, Elke Raes, and the laboratory technicians involved in the DRUID project.

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